

SUMMARY OF SCIENTIFIC/TECHNICAL PAPERS IN THIS ISSUE

Significance of non-level walking on transtibial prosthesis fitting

S.W. Sin, MPhil; Daniel H.K. Chow, PhD;
Jack C.Y. Cheng, MD (*p. 1*)

Purpose of the Work. The purpose of this study to investigate the clinical significance of non-level walking on transtibial prosthesis fitting. **Subject/Procedures.** The acceptable prosthesis alignment ranges of six subjects with transtibial amputation on level and non-level walking were determined and compared. With the aid of a recently developed alignment jig, prosthesis fitting was performed for each subject with varied anterior-posterior alignments. Conventional assessments and the subject's comment were used to determine whether the alignment was acceptable or not. **Results.** It was shown that the acceptable alignment range for non-level walking consistently fell within and was about half of that for level walking. **Relevance to the Veteran Population.** It was evident that non-level walking is important for better approximation of optimum alignment and should be included in routine prosthesis fitting.

S.W. Sin, MPhil; Daniel H.K. Chow, PhD; Jack C.Y. Cheng, MD

Effect of endurance training program based on anaerobic threshold (AT) for lower limb amputees

T. Chin, MD, PhD; S. Sawamura, MD; H. Fujita, MD;
S. Nakajima, MD; I. Ojima, RPT; H. Oyabu, RPT;
Y. Nagakura, RPT; H. Otsuka, PO;
A. Nakagawa, Engineer (*p. 7*)

Purpose of the Work. The purpose of this study is to investigate whether or not endurance training based on anaerobic threshold (AT) is useful in improving the physical fitness of lower limb amputees. **Subjects/Procedures.** Subjects were 14 unilateral trans-femoral amputees undertaking endurance training. Ten unilateral trans-femoral amputees served as control. The training program was designed so that the subjects would exercise at a target heart rate corresponding to AT point for 30

minutes per day, 3 to 5 days each week for 6 weeks. After training periods, physical fitness evaluation was performed. **Results.** After the training periods in the training subjects, physical fitness was improved significantly. On the contrary, no changes occurred in the control subjects. **Relevance to the Veteran Population.** Our chosen training program is of value in improving the physical fitness of amputees. Implementation of endurance training for veterans with lower limb amputation prepares for their return to active life in the community.

T. Chin, MD, PhD; S. Sawamura, MD; H. Fujita, MD; S. Nakajima, MD; I. Ojima, RPT; H. Oyabu, RPT; Y. Nagakura, RPT; H. Otsuka, PO; A. Nakagawa, Engineer

Erythema detection algorithm validity

Brian Riordan, MEBME; Stephen Sprigle, Ph.D., PT;
Maureen Linden, MSBME (*p. 13*)

Purpose of the Work. The objective of this study was to compare the reliability and validity of erythema detection algorithms. Erythema or "skin redness" can be a sign of tissue damage resulting from pressure on the skin. Erythema is often the first sign of a pressure ulcer. Skin redness is often used to identify areas at risk of pressure ulcer development. However, skin pigmentation can often mask the presence of erythema. In other words, erythema is hard to see in people with darkly pigmented skin, thus putting them at increased risk for pressure ulcers. The use of reflected light, called spectroscopy, can identify erythema even when the human eye cannot visualize it. **Subjects/Procedures.** Erythema was induced in 20 subjects who had varying levels of skin pigmentation. Spectroscopy measures were taken at the test site and two adjacent sites. Six erythema detection algorithms were tested to determine their abilities to identify erythema when present (sensitivity) and to determine their abilities to correctly identify when erythema was not present (specificity). **Results.** Two algorithms, Diffey and HHH-Beta, had sensitivity exceeding 85% and specificity exceeding 75%, but most algorithms demonstrated adequate validity across all subjects. **Relevance to the Veteran Population.** The results of this comparison will be useful to researchers interested in using spectroscopy to detect erythema in people with differing skin pigment levels. One specific benefit of a robust erythema detec-

tion algorithm is the development of an erythema detector for use by health care professionals to detect erythema. Many veterans are at risk of developing pressure ulcers, including those with amputation and those who use wheelchairs. Early detection of erythema, especially in Veterans with darkly pigmented skin, can help reduce the occurrence of pressure ulcers.

Brian Riordan, MEBME; Stephen Sprigle, Ph.D., PT; Maureen Linden, MSBME

The design of a compliant composite crutch

Dorota Shortell, MSME; Jeff Kucer, MSME;
W. Lawrence Neeley, BSME; Maurice LeBlanc,
MSME, CP (p. 23)

Purpose of the Work: To design and develop a crutch that will offer improved comfort and reduced injury and energy expenditure for the user. **Results:** An “S”-shaped crutch made of carbon fiber composite material was designed, fabricated and tested with seven users of crutches. Results are encouraging and the project is being continued. **Relevance to the Veteran Population:** The basic design of crutches has not changed significantly for over 5000 years. The new crutch offers potential improvement in function and appearance for veterans using crutches.

Dorota Shortell, MSME; Jeff Kucer, MSME; W. Lawrence Neeley, BSME; Maurice LeBlanc, MSME, CP

Physical capacity and race performance of handcyle users

Thomas W. J. Janssen, PhD; A.J. Dallmeijer, PhD;
L.H.V. van der Woude, PhD (p. 33)

Purpose of the Work. Handcycling has become popular for sports and daily use activities among wheelchair users. The purpose of this study was to evaluate the physical capacity and race performance of handcyle users. **Subjects/ Procedures.** Sixteen male participants of a 10K race, 10 with and 6 without upper-limb impairment, performed a graded exercise test in a handcyle system attached to their regular wheelchair. Also, heart rate during the race was recorded to estimate the physical strain of handcycling and the average race velocity was calculated. **Results.** The physical capacity, estimat-

ed by the maximal power output achieved, was considerably higher than normally found for wheelchair use. Race velocity was high, even for those with upper-limb impairments, and the physical strain appeared adequate for aerobic training. **Relevance to the Veteran Population.** Handcycling appears to enable wheelchair users, even those with upper-limb impairments, to achieve high power output levels and velocities, which could increase their range of action and reduce dependency.

Thomas W.J. Janssen, PhD; A.J. Dallmeijer, PhD; L.H.V. van der Woude, PhD

Dynamic calibration of a wheelchair dynamometer

Carmen P. DiGiovine, MS; Rory A. Cooper, PhD;
Michael L. Boninger, MD (p. 41)

Purpose of the Work: The purpose of this study was to describe and implement a dynamic calibration test in order to characterize the electro-mechanical properties of a dynamometer. A dynamometer is a stationary roller system for wheelchair users. A treadmill is the equivalent for walking or running. **Procedures:** The inertia and friction of the roller system, as well as the electrical characteristics of the motors attached to the roller system, were measured using three different methods. **Results:** The most appropriate method determines all of the electro-mechanical parameters simultaneously using a nonlinear regression analysis. Though it is the most complex method, it is the most appropriate since the errors associated with the other two methods are large when calculating the power produced by the individual. Power and velocity are the two parameters typically reported by researchers since no two roller systems are exactly the same. **Relevance to the Veteran Population:** The measurement of the electro-mechanical properties of the dynamometer provides the information necessary to simulate real-world conditions. This will allow for more accurate physiological and biomechanical testing of veterans who use a wheelchair. This can then lead to improved propulsion techniques for manual wheelchair users (e.g. reduced overuse injuries of the shoulders and wrists), and improved or alternative joysticks for electric-powered wheelchair users.

Carmen P. DiGiovine, MS; Rory A. Cooper, PhD; Michael L. Boninger, MD

A comparison of methods to compute the point of force application in handrim wheelchair propulsion: a technical note

Michelle B. Sabick; Kristin D. Zhao;
Kai-Nan An (p. 57)

Purpose of the Work. The purpose of this study was to quantify the differences between methods used to calculate the point of force application (PFA) during wheelchair propulsion. **Subjects/Procedures.** The forces and torques exerted on the handrim were measured using force transducers as subjects propelled their wheelchairs. Five adult male wheelchair users with low-level paraplegia (T12\NL1) who had been using a manual wheelchair for at least 2 years were studied. We compared five different techniques for computing the PFA location. The effects of these techniques on the calculated force and efficiency were quantified. **Results.** The most consistent and stable results were obtained by assuming that components of the handrim moment about the anteriorly directed and vertically directed axes were negligible. All PFA values calculated with kinetic data were unstable at the beginning and end of the propulsion phase. The efficiency calculated with the different methods was not the same. **Relevance to the Veteran Population.** Location of the PFA is important for determining a wheelchair user's efficiency. Since improving efficiency is a goal of many researchers, understanding the limitations of the calculations is important. We have shown that the equations used to calculate the location of the PFA greatly affect the results. Therefore, comparisons between different data sets may not be appropriate.

Michelle B. Sabick; Kristin D. Zhao; Kai-Nan An

The effect of treadmill training on the ambulation of stroke survivors in the early stages of rehabilitation

Yocheved Laufer, D.Sc, PT; Ruth Dickstein, D.Sc, PT;
Yael Chefez, BA, PT; Emanuel Marcovitz MD (p. 69)

Purpose of the Work. The purpose of this study was to examine the effects of treadmill training on the restoration of gait in people with hemiparesis following a stroke. **Subjects/Procedures.** Twenty-five individuals following a recent stroke participated in the study. In addition to conventional physical therapy, 13 subjects participated in 15 treadmill training sessions and 12 subjects received the same number of equal-length sessions of over-ground ambulation. **Results.** Treadmill training is feasible and

well tolerated by subjects with hemiparesis even in the early stages of gait rehabilitation. Subjects trained with the treadmill improved their functional gait, stance symmetry, and stride length more than subjects treated by over-ground gait training. **Relevance to the Veteran Population.** Treadmill training can be implemented early on in the rehabilitation program of subjects with hemiparesis. Such training can enhance the restoration of functional gait abilities of post stroke subjects.

Yocheved Laufer, D.Sc, PT; Ruth Dickstein, D.Sc, PT; Yael Chefez, BA, PT; Emanuel Marcovitz MD

Exercise program designs for older adults

Lisa Boyette, MEd and James E. Boyette, MS (p. 79)

Purpose of the Work. This study created a computerized exercise expert system (EES) that creates a standardized assessment and counseling protocol providing individualized exercise plans for older adults. **Subjects/Procedures.** A national meeting of 18 local and national experts was held to critique the EES. Case study analyses focused on examination of the exercise plans and strategies created by the EES. Discrepancies between recommended strategies in the plan and expert opinion were cross-examined until consensus was reached on the appropriate exercise plan for each individual case. **Results.** The EES demonstrated adequate inter-rater reliability and criterion validity (greater than .80). There was an 88% agreement between the experts that the EES user interface for user-friendliness was excellent. **Relevance to the Veteran Population.** The EES helps health providers create tailored exercise plans for healthy older adults. These individualized exercise plans consist of a client's report, customized exercise prescription, recommended strategies, and an exercise knowledge sheet.

Lisa Boyette, MEd and James E. Boyette, MS

The Spasticity Evaluation Test (SeT): A pilot study

M. S. Scattareggia; P. Di Bella; E. Sessa; S. Donato;
P. Bramanti (p. 93)

Purpose of the Work. Spasticity is normally evaluated through semi-qualitative scales that do not allow to measure the presence of the disorder accurately. The purpose of this study was to design and develop an apparatus aimed at evaluating clinically the presence of spasticity affecting the elbow. **Subjects/Procedures.** The test is

performed with the patient seated or laying in the most comfortable position with the machine located in front of the side to be examined. The data set acquired is then processed by an algorithm whose output is the force exerted by the muscles at a known speed. **Results.** The tests carried out have shown an easy use of the apparatus in the clinical setting. The preliminary source has indicated that a greater accuracy is obtained when the test is executed during elbow flexion. **Relevance to the Veteran Population.** These measurements will allow researchers to better evaluate the effects of any rehabilitative treatment aimed at reducing the effect of this disabling condition.

M. S. Scattareggia; P. Di Bella; E. Sessa; S. Donato; P. Bramanti

Meeting the intent of ADA in sidewalk cross-slope design

Kara Kockelman, MCP, BS, MS, PhD CE;
Yong Zhao, MS, CE; Chessie Blanchard-Zimmerman,
MCP (*p. 101*)

Purpose of the Work. The purpose of this study is the evaluation of usable ranges of sidewalk cross-slopes through explicitly consideration of user perception and effort. **Subjects/Procedures.** Twenty subjects ranging widely in age and type of mobility aid participated in field surveys where they traversed different sidewalk sections varying in cross-slope, primary grade, length, width and other characteristics. Statistical regression models were used to analyze disabled-user response to these difference sidewalk characteristics. **Results.** The calibrated models permit estimation of maximum sidewalk cross-slopes consistent with the intent and spirit of the Americans with Disabilities Act and its Accessibility Guidelines. These are estimated to be four percent—where feasible—and ten percent—where unfavorable construction conditions exist. **Relevance to the Veteran Population.** Such results should prove useful for consideration of the final requirements of ADA on this topic, rendering sidewalks accessible to users with disabilities.

Kara Kockelman, MCP, BS, MS, PhD CE; Yong Zhao, MS, CE; Chessie Blanchard-Zimmerman, MCP

SLO Radiant Power and Brightness

Rolf W. Nygaard, PhD and Ronald A. Schuchard, PhD
(*p. 123*)

Purpose of the Work. We propose a means of expressing the radiant power of the Scanning Laser Ophthalmoscope (SLO) in units of brightness. **Procedures.** By a combination of geometric deduction and measurement, we determine the relationship between SLO radiant power and brightness. We also measure brightnesses of everyday objects and relate them to SLO radiant power. **Results.** We obtain conversion factors that permit SLO power to be expressed in units of brightness. Inversely, these factors permit brightnesses of everyday objects to be expressed in units of SLO power. Examples are given. **Relevance to the Veteran Population.** Expressing SLO power in brightness terms common to everyday activities greatly aids the understanding of visual impairment.

Rolf W. Nygaard, PhD and Ronald A. Schuchard, PhD

SLO Power Calibration

Rolf W. Nygaard, PhD and Ronald A. Schuchard, PhD
(*p. 129*)

Purpose of the Work. We propose a method for calibrating the Scanning Laser Ophthalmoscope (SLO) that predicts radiant power output at any setting of laser attenuation. **Procedures.** Predicted power values are determined by substitution into adjusted polynomial functions of power vs. laser attenuation. These are compared with observed power values over a range of attenuation settings and measurement sessions. The proportion of successful pairwise comparisons defines predictive accuracy. **Results.** The greatest predictive accuracy is obtained with a 5th degree polynomial fit to power at designated values of laser attenuation in an arbitrary session and then adjusted to the maximum power in each new session. **Relevance to the Veteran Population.** Our method provides accuracy of SLO power with little calibration effort. This dual feature is valuable to the therapist in the evaluation of visual impairment.

Rolf W. Nygaard, PhD and Ronald A. Schuchard, PhD

Reduced forces accompany device use during sliding transfers of seated subjects

Peter Grevelding, MSPT and
Richard W. Bohannon, EdD (*p. 135*)

Purpose of the Work. We sought in this study to determine how much the forces associated with horizontal transfers could be reduced by the use of commercially available assistive devices. **Subjects/Procedures.** Fourteen individuals were pushed horizontally as they sat passively on a padded mat. They sat either directly on the mat or on a sliding board, a fabric tube, or a fabric

tube and sliding board that were placed on top of the mat. The forces required to move the individuals were registered by a force gauge that was pushed against the left hip of each subject. **Results.** The sliding board and the fabric tube both reduced push forces. The greatest reduction in force, however, was associated with use of the board and tube together. **Relevance to the Veteran Population.** Individuals requiring sliding boards for transfers may find that incorporating a fabric tube may make the transfers easier for them or those who are helping them.

Peter Grevelding, MSPT and Richard W. Bohannon, EdD